

CLAIMS

What is claimed is:

- 5 1. In a data storage system, a method for detecting errors in data to be stored within the data storage system, the method comprising the steps of:
- receiving data at the data storage system;
  - receiving application error checking information at the data storage system;
  - generating data storage error checking information on the data received in the data
- 10 storage system; and
- comparing the application error checking information in a format that is compatible with the data storage error checking information, to the data storage error checking information, to determine if the data received in the data storage system contains an error upon receipt, and if the data contains an error, providing an indication
- 15 of the error, and if the data does not contain an error, storing the data within the data storage system.
2. The method of claim 1 wherein the step of receiving data includes the step of:
- receiving a portion of data;
- 20 generating data portion error checking information for the portion of data; and
- repeating the steps receiving a portion of data and generating data portion error checking information until all portions of data are received that comprise an application data block for which an application that originates the data computed the application error checking information upon.
- 25 3. The method of claim 2 wherein:
- the data portion error checking information is an N-byte checksum value respectively generated in the data storage system for each portion of data that is received;
- and

the step of generating data storage error checking information computes an N-byte value for the data storage error checking information by performing an exclusive-or on all N-byte checksum values for all portions of data that are received that comprise the application data block.

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4. The method of claim 3 wherein:

the application error checking information is an M-byte checksum value, computed by the application that originates the data, on all portions of data that comprise the application data block; and

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wherein the method further includes the step of:

converting the application error checking information M-byte value into an N-byte value such that the step of comparing can compare the data storage error checking information with the application error checking information to determine if the application data block comprised of the portions of data received contains an error.

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5. The method of claim 4 wherein the application error checking information is embedded within at least one portion of data that is received, and wherein the step of converting includes the step of:

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extracting the application error checking information from that at least one portion of data in which the application error checking information is embedded.

6. The method of claim 2 wherein the step of generating data storage error checking information includes the steps of:

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combining the data portion error checking information generated for each portion of data received in order to generate the data storage error checking information, such that the data storage error checking information is comparable in a manner that is compatible with the application error checking information to determine if the application data block comprised of the portions of data received contains an error.

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7. The method of claim 1 wherein the step of receiving data includes the steps of:

receiving multiple portions of data that comprise an application data block; and

5 generating data portion error checking information for each portion of data in the application data block; and

wherein the step of generating data storage error checking information includes the step of:

10 combining the data portion error checking information generated for each portion of data that comprises the application data block in order to generate the data storage error checking information; and

wherein the method further includes the step of:

15 determining if the application error checking information is comparable to the data storage error checking information, and if it is not comparable, converting the application error checking information into a format that is comparable with the data storage error checking information and proceeding to perform the step of comparing, and if it is comparable, proceeding to perform the step of comparing.

20 8. The method of claim 1 wherein the step of generating data storage error checking information generates data storage error checking information on application data for which an application that originates that application data generates the application error checking information upon.

9. The method of claim 1 further including the steps of:

25 receiving a configuration command at the data storage system, the configuration command indicating to the data storage system at least one of:

i) a designation of a portion of storage within the data storage system for storing the data processed by the steps of receiving, generating and comparing;

ii) an indication of areas in the portion of storage that do not contain data including application error checking information;

iii) an indication of a location of application error checking information within an application data block that comprises the data that is received; and

iv) an indication of a size of the application data block.

5 10. The method of claim 9 further including the step of:

in response to receiving the configuration command, designating the portion of storage within the data storage system for storing the data processed by the steps of receiving, generating and comparing, such that data received that is to be stored in the designated portion of storage is subjected to the steps of generating data storage error checking information and comparing the application error checking information to the data storage error checking, and such that an error in the data received that is to be stored in the designated portion of storage is detected upon receipt of the data by the data storage system.

15 11. The method of claim 9 further including the step of:

in response to receiving the configuration command, the step of generating data storage error checking information on the data received in the data storage system excludes generating data storage error checking information on data that is to be stored within the portion of storage that does not contain data including application error checking information.

20 12. The method of claim 1 wherein:

the data is database data generated by a database application;

the application error checking information is software generated checksum

25 information generated on portions of the database data by the database application and is embedded within the database data received; and

the step of generating data storage error checking information applies, within the data storage system, a data storage error checking checksum algorithm to the database data received that is compatible with a software application error checking algorithm used by the database application to create the application error checking information,

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such that the data storage error checking algorithm produces a data storage error checking information result that the step of comparing can use to compatibly compare with the application error checking information to determine if the data received contains an error.

5 13. The method of claim 12 wherein the database application is an Oracle database application and wherein the database data is Oracle database data and wherein the application error checking information is an embedded Oracle checksum received with the Oracle database data at a predetermined offset in an Oracle application data block.

10 14. The method of claim 1, wherein if the step of comparing determines that the data received in the data storage system contains an error, the step of providing an indication of the error includes providing, to a software application that originated the data, a rejection of at least one input-output request performed to receive the data in the data storage system.

15 ~~15.~~ A data storage system comprising:  
an interface receiving data and receiving application error checking information;  
an error detection component;  
at least one storage device;  
20 an interconnection mechanism coupling the interface, the error detection component and the at least one storage device; and  
wherein the error detection component operates in the data storage system to detect errors in data to be stored within the data storage system by:  
generating data storage error checking information on the data received by  
25 the interface;  
comparing the application error checking information in a format that is compatible with the data storage error checking information, to the data storage error checking information, to determine if the data received in the data storage system contains an error upon receipt, and if the data contains an error, providing

an indication of the error, and if the data does not contain an error, storing the data within the at least one storage device in the data storage system.

16. The data storage system of claim 15 wherein the interface receives data by receiving a portion of data; and

wherein the error detection component further includes a data portion error checking information generator coupled to the interface; and

wherein the data portion error checking information generator generates data portion error checking information for the portion of data received by the interface; and

wherein the interface and the data portion error checking information generator repeat the operations of i) receiving a portion of data and ii) generating data portion error checking information, until all portions of data are received by the interface that comprise an application data block for which an application that originates the data computed the application error checking information upon.

17. The data storage system of claim 16 wherein the error detection component further includes:

a data portion error checking information generator coupled to the interface; and

a data storage error checking information generator coupled to the data portion error checking information generator; and

wherein the data portion error checking information is an N-byte checksum value respectively generated by the data portion error checking information generator for each portion of data that is received by the interface; and

wherein when the error detection component generates the data storage error checking information, the data storage error checking information generator computes an N-byte value for the data storage error checking information by performing an exclusive-or on all data portion error checking information N-byte checksum values for all portions of data that are received by the interface that comprise the application data block.

18. The data storage system of claim 17 wherein:

the application error checking information is an M-byte checksum value computed by the application that originates the data on all portions of data that comprise the application data block; and

wherein the error detection component further includes an application error checking information extractor coupled to the interface which converts the application error checking information M-byte value into an N-byte value such that the error detection component, when performing the operation of comparing, can compare the data storage error checking information with the application error checking information to determine if the application data block comprised of the portions of data received in the memory system contains an error.

19. The data storage system of claim 18 wherein the application error checking information is embedded within at least one portion of data that is received by the interface, and wherein when application error checking information extractor converts the application error checking information, the application error checking information extractor extracts the application error checking information from that at least one portion of data which the application error checking information is embedded.

20. The data storage system of claim 16 wherein the error detection component further includes:

a data storage error checking information generator coupled to the data portion error checking information generator; and

wherein when the error detection component performs the operation of generating data storage error checking information, the data storage error checking information generator combines the data portion error checking information generated for each portion of data received at the interface in order to generate the data storage error checking information, such that the data storage error checking information is comparable by the error detection component in a manner that is compatible with the application error checking information such that the error detection component can

determine if the application data block comprised of the portions of data contains an error.

21. The data storage system of claim 15, wherein:

- 5           the interface includes an input-output request handler that operates to receive multiple portions of data that comprise an application data block; and
- wherein the error detection component includes:
- a data portion error checking information generator, coupled to the input-output request handler, that generates data portion error checking information for each portion of
- 10       data in the application data block;
- a data storage error checking information generator, coupled to the data portion error checking information generator, that combines the data portion error checking information generated for each portion of data that comprises the application data block in order to generate the data storage error checking information;
- 15       an application error checking information extractor, coupled to the input-output request handler, that determines if the application error checking information is comparable to the data storage error checking information, and if it is not comparable, converts the application error checking information into a format that is comparable with the data storage error checking information.

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22. The data storage system of claim 15 wherein the error detection component generates data storage error checking information on application data for which an application that originates that application data generates the application error checking information upon.

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23. The data storage system of claim 15 wherein the interface receives a configuration command indicating to the data storage system at least one of:

- i) a designation of a portion of storage within that at least one storage device in the data storage system for storing the data processed by the steps of receiving,
- 30       generating and comparing;



ii) an indication of areas in the portions of storage that do not contain data including application error checking information;

iii) an indication of a location of application error checking information within an application data block that comprises the data that is received; and

5 iv) an indication of a size of the application data block.

24. The data storage system of claim 23 wherein the interface, in response to receiving the configuration command, causes the data storage system to designate the portion of storage within the data storage system for storing the data processed by the error  
10 detection component, such that data received by the interface that is to be stored in the designated portion of storage is subject to processing by the error detection component, and such that an error in the data received that is to be stored in the designated portion of storage is detected upon by the error detection component upon receipt of the data by the data storage system.

15 25. The data storage system of claim 23 wherein, in response to receiving the configuration command, the error detection component generates data storage error checking information on the data received in the data storage system excludes generating data storage error checking information on data that is to be stored within the portion of  
20 storage that does not contain data including application error checking information.

26. The data storage system of claim 15 wherein:

the data is database data generated by a database application;

the application error checking information is software generated checksum

25 information generated on portions of the database data by the database application and is embedded within the database data received; and

the error detection component applies a data storage error checking checksum algorithm to the database data that is compatible with a software application error checking algorithm used by the database application to create the application error

30 checking information, such that the data storage error checking algorithm produces a data

storage error checking information result that the error detection component can use to compatibly compare with the application error checking information to determine if the data received contains an error.

- 5 27. The data storage system of claim 26 wherein the database application is an Oracle database application and wherein the database data is Oracle database data and wherein the application error checking information is an embedded Oracle checksum received by the error detection component with the Oracle database data at a predetermined offset in an Oracle application data block.

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28. The data storage system of claim 15, wherein if the error detection component determines in the comparing operation that the data received in the data storage system contains an error, the error detection component provides an indication of the error to a software application that originated the data and the interface rejects of at least one input-output request performed to receive the data in the data storage system.

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29. A computer program product having a computer-readable medium including computer program logic encoded thereon that when performed on a data storage system, causes the data storage system to detect error in data to be stored in the data storage system, and wherein when the computer program logic is performed on at least one processor in the data storage system system, the computer program logic causes the at least one processor to perform the operations of:

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- receiving data at the data storage system;
- receiving application error checking information at the data storage system;
- generating data storage error checking information on the data received in the data storage system; and

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- comparing the application error checking information in a format that is compatible with the data storage error checking information, to the data storage error checking information, to determine if the data received in the data storage system contains an error upon receipt, and if the data contains an error, providing an indication

of the error, and if the data does not contain an error, storing the data within the data storage system.

30. The computer program product of claim 29 wherein the computer program logic that performs the step of generating data storage error checking information, when performed on the at least one processor, causes the at least one processor to perform the step of:

combining the data portion error checking information generated for each portion of data received in order to generate the data storage error checking information, such that the data storage error checking information is comparable in a manner that is compatible with the application error checking information to determine if the application data block comprised of the portions of data received contains an error.

31. The computer program product of claim 29 wherein the computer program logic that performs the step of receiving data, when performed on the at least one processor, causes the at least one processor to perform the steps of:

receiving multiple portions of data that comprise an application data block; and

generating data portion error checking information for each portion of data in the application data block; and

wherein the computer program logic that performs the step of generating data storage error checking information, when performed on the at least one processor, causes the at least one processor to perform the steps:

combining the data portion error checking information generated for each portion of data that comprises the application data block in order to generate the data storage error checking information; and

wherein the computer program logic, when performed on the at least one processor, causes the at least one processor to further perform the steps of:

determining if the application error checking information is comparable to the data storage error checking information, and if it is not comparable, converting the application error checking information into a format that is

comparable with the data storage error checking information and proceeding to perform the step of comparing, and if it is comparable, proceeding to perform the step of comparing.

- 5 32. The computer program product of claim 29 wherein the computer program logic, when performed on the at least one processor, causes the at least one processor to further perform the step of:

receiving a configuration command at the data storage system, the configuration command indicating to the data storage system at least one of:

- 10 i) a designation of a portion of storage within the data storage system for storing the data processed by the steps of receiving, generating and comparing;
- ii) an indication of areas in the portion of storage that do not contain data including application error checking information;
- 15 iii) an indication of a location of application error checking information within an application data block that comprises the data that is received; and
- iv) an indication of a size of the application data block.

33. A data storage system comprising:

- 20 an interface including a means for receiving data and a means for receiving application error checking information;
- an error detection component;
- at least one storage device;
- an interconnection mechanism coupling the interface, the error detection component and the at least one storage device; and
- 25 wherein the error detection component operates in the data storage system to detect errors in data to be stored within the data storage system and includes:
- means for generating data storage error checking information on the data received by the interface;
- 30 means for comparing the application error checking information in a format that is compatible with the data storage error checking information, to the

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Variable	Mean	SD	Min	Max
Age	38.5	12.5	25	65
Gender	0.5	0.5	0	1
Marital status	0.7	0.5	0	1
Education	12.5	1.5	10	15
Income	3500	1500	1000	8000
Health status	0.8	0.4	0	1
Exercise frequency	0.3	0.5	0	1
Stress level	0.6	0.5	0	1
Sleep quality	0.7	0.4	0	1
Diet quality	0.6	0.5	0	1
Work-life balance	0.5	0.5	0	1
Family support	0.8	0.4	0	1
Community involvement	0.4	0.5	0	1
Life satisfaction	0.7	0.4	0	1
Overall well-being	0.6	0.5	0	1